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Original Research Article

Global Catastrophizing vs Catastrophizing Subdomains: Assessment and Associations with Patient Functioning

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Abstract

Objective. The primary objectives of the current study were to 1) confirm the three-factor model of the Pain Catastrophizing Scale (PCS) items in a Japanese sample and 2) identify the catastrophizing subdomain(s) most closely associated with measures of pain and functioning in a sample of individuals with chronic pain.

Design. This was based on a cross-sectional observational study.

Setting. This study was conducted in a university-based clinic.

Patients. One hundred and sixty outpatients with chronic pain participated in this study.

Outcome Measures. Patients completed the PCS, the Brief Pain Inventory, and the Hospital Anxiety and Depression Scale; 30 patients completed the PCS again between 1 and 4 weeks later.

Results. Confirmatory factor analysis supported a three-factor structure of the Japanese version of the PCS, and univariate and multivariate associations with validity criterion supported the validity of the measure. Catastrophic helplessness was shown to make a unique contribution to the prediction of pain intensity, pain interference and depression, and catastrophic magnification made a unique contribution to the prediction of anxiety.

Conclusions. The findings support the cross-cultural generalizability of the three-factor structure of the PCS and indicate that the PCS-assessed catastrophizing subdomains provide greater explanatory power than the PCS total score for understanding pain-related functioning.

Key Words. Catastrophizing; Helplessness; Confirmatory Factor Analysis; Pain Catastrophizing Scale; Chronic Pain

Introduction

Pain-related catastrophizing has been defined as "an exaggerated negative orientation toward pain stimuli and pain experience" [1]. Catastrophizing is generally viewed as a maladaptive response to pain, and a large and growing body of research supports the importance of catastrophizing as a predictor of patient functioning [1–16]. Moreover, research supports catastrophizing as a potential mechanism that may explain chronic pain

treatment outcome [2–5]. The most common measures of catastrophizing used in this research are the catastrophizing scale of the Coping Strategies Questionnaire (CSQ) [17] and the Pain Catastrophizing Scale (PCS) [1]. The 6-item CSQ catastrophizing scale assesses global catastrophizing and has shown consistent associations with measures of pain intensity and functioning in individuals with chronic pain [18]. The 13-item PCS assesses three catastrophizing domains: Helplessness (five of the six items in this scale were drawn from the CSQ catastrophizing scale), Rumination, and Magnification. However, in the vast majority of studies that use the PCS, the overall composite score representing global catastrophizing is used [6,9–11,16].

Fewer studies have examined the relative importance of the specific catastrophizing subdomains. In the research that has been performed, the PCS Helplessness and Rumination scales have tended to be more consistently associated with measures of pain and pain-related functioning than the Magnification scale [7,12–15]. Specifically, the PCS Helplessness scale has been shown to be more strongly associated with poorer psychological functioning [8,19], pain intensity [20–22], and pain interference [23] than the other PCSs. Moreover, early-treatment reductions in catastrophic helplessness have been shown to predict late-treatment decrease in pain and interference, supporting a possible causal effect of this catastrophizing subdomain on these outcome variables [4]. In a different sample of patients, Sullivan and colleagues found that the PCS Rumination scale was the strongest predictor of pain and disability [24–26]. We were only able to identify two studies in which the PCS Magnification scale demonstrated significant associations with a criterion measure. In these studies, magnification catastrophizing contributed a significant amount of unique variance to the prediction of pain intensity (but not disability) in a sample of patients with whiplash injury [27] and in woman suffering from provoked vestibulodynia [28]. However, although some researchers have reported significant associations between measures of global catastrophizing and anxiety (e.g., [29]), we were unable to identify any study directly demonstrating that the catastrophizing subdomains predict anxiety in persons with chronic pain.

Because of the importance of catastrophizing for understanding adjustment to pain, and the demonstrated reliability and validity of PCS, the PCS has been translated into a number of languages, including Japanese, and some preliminary research on the cross-cultural generalizability of the importance of catastrophizing have been published [30–33]. One study found that PCS was significantly associated with pain intensity and pain interference in a sample of undergraduate Japanese students [34]. In a second study in a small (N = 46) sample of Japanese patients with burning mouth syndrome, catastrophizing was found to be significantly associated with pain intensity and a number of quality of life domains, such as psychological disability, social disability, and perceived handicap [35]. The findings from these initial studies suggest that the importance of catastrophizing to chronic pain adjustment found in patients from Western countries might generalize across cultures to patients from Japan. However, the importance of catastrophizing as a predictor of pain and dysfunction in samples of Japanese patients with mixed chronic pain problem samples has yet to be tested. Understanding the cross-cultural generalizability of findings is important as it speaks to the potential universality (vs specificity) of the findings, as well as the potential effects of culture on those findings.

Recently, several studies have examined the associations between ethnic group membership and catastrophizing in comparative studies using samples of African Americans, Hispanics, Asians, and Caucasians [35–37,39]. Two studies have found that catastrophizing mediated the associations between ethnicity and affective [38] and sensory pain responses [37]. Thus, catastrophizing may play an important role in understanding the differences in response to pain sometimes found between various ethnic and cultural groups.

As mentioned earlier, the PCS was originally developed to assess three domains of catastrophizing, and a number of exploratory and confirmatory factor-analytic studies in samples of patients from the United States have generally supported the three-factor structure of the PCS [30,40]. However, two studies suggest that a two-factor model (Rumination and a combination of the PCS Magnification and Helplessness scores) may be more appropriate in some samples [41,42]. The PCS factor structure has never been examined in Japanese patients with chronic pain; analyses to address this gap would be helpful to determine the cross-cultural generalizability of the two- vs three-factor structure of the PCS items.

As a group, the findings to date indicate that different catastrophizing domains may predict different pain-related criterion variables, although research suggests that helplessness catastrophizing may be more consistently associated with pain intensity and pain interference than the other catastrophizing domains. Additional research is needed to determine the relative importance of the different catastrophizing domains as they relate to pain intensity, pain interference, and psychological dysfunction, including anxiety. Such research has important clinical implications as it would be useful for clinicians to know which type of catastrophizing cognition(s) may need the most attention as targets of cognitive behavioral interventions in patients with chronic pain.

Given the above considerations, the primary objectives of the current study were to 1) confirm the three-factor model of the PCS items and 2) identify the catastrophizing subdomain(s) most closely associated with patient functioning in our clinical sample. Regarding the first objective, we hypothesized that a three-factor model of the PCS items would evidence the greatest support.

Regarding the second objective, and based on the limited research that has studied the importance of the specific PCS subscales, we hypothesized that the PCS Helplessness subscale would evidence the strongest associations with the criterion variables of pain intensity, pain interference, and psychological dysfunction. A secondary study objective was to evaluate the psychometric properties of the (Japanese) translated version of the PCS used in this study, to help determine the cross-cultural applicability of the construct as well as the PCS's ability to assess that construct in non-English-speaking patients with chronic pain.

Methods

Participants

The study participants were consecutive patients with chronic pain evaluated for possible treatment from April 2006 to September 2009 in the Department of Psychosomatic Medicine at Kyushu University Hospital in Japan. Eligibility criteria included: 1) 3 month or more history of pain; 2) an ability to read and write Japanese; 3) being 20 years old or older; and 4) a willingness to participate in the study. Exclusion criteria included: 1) the presence of psychotic symptoms; 2) an inability to read due to visual impairment; and 3) lack of consent for study participation. Seventy-three participants are excluded mainly because their pain duration was less than 3 months. There were no significant differences between participants and nonparticipants in age or sex distribution.

The study participants were asked to complete a number of pain-related measures while waiting for their consultation. The first 30 participants completed the Japanese version of the PCS (J-PCS) twice within 4 weeks (in the hospital and at home) in order to compute test–retest stability statistics for the measure in our sample. Only 30 participants were asked to provide retest J-PCS data because we determined that more were not needed for computing test–retest stability coefficients, and we wished to minimize assessment burden for the study participants. Participant responses to all questionnaires were reviewed by a research staff member when the data were collected, and any missing data or inappropriate responses were discussed with the patient to ensure as complete and accurate data as possible.

Measures

Japanese Version of the Pain Catastrophizing Scale

All participants completed the Japanese version of the Pain Catastrophizing Scale (J-PCS) [34]. The J-PCS consists of 13 items describing thoughts and feelings that individuals may have when experiencing pain. The J-PCS instructions ask participants to reflect on past painful experiences (no recollection time period is specified) and to indicate the degree to which they experienced each of 13 thoughts or feelings when experiencing pain on a 5-point Likert scale (ranging from 0 = "Not at all" to 4 = "All the time"). The J-PCS can be scored as an overall composite measure of catastrophizing (total score) or as three subscales representing each of three catastrophizing domains (assessing Rumination, Magnification, and Helplessness). Previous research with the English version of the PCS has shown adequate to excellent internal consistency for most of the scales (e.g., Cronbach's α: total PCS = 0.87, Rumination = 0.87, and Helplessness = 0.79), although the Cronbach's α for the Magnification scale has been marginal in most studies (e.g., α as low as 0.60) [1,24,25,43]. The internal consistencies of the J-PCS found in a nonclinical sample have replicated these findings (Cronbach's α for the total scale = 0.89, Rumination = 0.80, Magnification = 0.65, Helplessness = 0.81) [34]. In an exploratory factor-analytic investigation, using a principal component analysis with oblique rotation, the J-PCS items were found to factor into three components that were labeled Rumination, Helplessness, and Magnification in a sample of students [34]. The item loadings for these factors were very similar to those found in studies using the English version (with item 12 loading onto the Helplessness rather than the Rumination subscale) [34].

Validity Criterion Measures

Participants were asked to complete measures to assess four criterion variables: pain intensity, pain interference, depression, and anxiety.

Pain Intensity and Pain Interference

A Japanese version of the Brief Pain Inventory (BPI) [44] was used to assess pain intensity and pain interference. The 11-item BPI was originally designed for patients with cancer, but the measure has been subsequently validated in a large number of additional patient populations. A Japanese version of the BPI has also been developed and validated in a sample of patients with cancer pain [44]. Four BPI items assess pain intensity (current pain, least pain, worst pain, and average pain), and seven items assess pain interference (with seven domains of functioning such as walking, sleep, mood, and relations with others). Previous research has shown the BPI scales assessing these two domains to have excellent reliability (with internal consistencies ranging from 0.78 to 0.95) and validity (as measured by an ability to detect response to treatment and be associated with other important pain-related variables) [45–47]. Although the original BPI asks patients to rate their pain intensity and interference in the last 24 hours, other researchers have expanded the time frame to 1 week [48]. We used the 7-day time frame in this study in order to be able to assess usual or characteristic pain and avoid unreliability in measurement due to possible daily fluctuations in pain. In the current sample, the BPI intensity and interference composite scores showed

excellent internal consistency (Cronbach's $\alpha = 0.84$ and 0.89, respectively).

Anxiety and Depression

The Hospital Anxiety and Depression Scale (HADS) is a widely used 14-item self-report measure of anxiety and depression [49]. It has demonstrated reliability and validity in numerous settings and across cultures [50]. A Japanese version of the HADS has been developed and was used in the present study to assess the level of anxiety and depression in the sample [49]. In our sample, the Anxiety and Depression HADS scores showed excellent internal consistency (Cronbach's $\alpha =$ 0.81 and 0.78, respectively).

Data Analysis

SPSS 17.0J for Windows (SPSS Japan Inc., Tokyo, Japan) was used to compute descriptive statistics and to test the study hypotheses. We first computed the means and standard deviations of the study measures for descriptive purposes. Next, to test the study hypothesis concerning the factor structure of the J-PCS, we performed a series of confirmatory factor analyses (CFA) using AMOS 17.0 (SPSS Japan Inc.). Three models were tested: 1) the original three-factor structure suggested by Sullivan and colleagues [1]; 2) the two-factor structure reported by Osman and colleagues [41]; and 3) the three-factor structure elaborated by the previous study with Japanese students [34]. As single-factor structures in which all the items were hypothesized to load on a unique latent factor were rejected by several studies, we did not evaluate a single-factor model [31,42]. Model fit was evaluated using χ^2 statistics. In addition, to determine the best suitable model, several goodness-of-fit measures were computed because the χ^2 statistics are affected by a number of factors, such as sample size. The goodness-of-fit measures used were: 1) incremental fit index (IFI), in which IFI values close to 1 indicate a very good fit [51]; 2) root mean square error of approximation (RMSEA), a measure of the discrepancy per degree of freedom in the model [52]; 3) comparative fit index (CFI), a measure to assess the relative fit of the hypothesized model to a baseline model; and 4) Akaike information criterion (AIC), whereby lower AIC score indicates a better fit [52]. RMSEA values <0.08 or less indicate a reasonable error of approximation [52]. CFI values close to 1 indicate a good fit [51]. To evaluate the reliability of the J-PCS in our sample, we computed Cronbach's α and the intraclass correlation coefficients (ICCs) for the J-PCS total scale and subscales. To evaluate the validity of the J -PCS in our sample, we computed Pearson's correlation coefficients between the J-PCS and the criterion variables. Finally, to test the hypothesis that the PCS Helplessness scale would evidence the strongest associations with the study criterion variables (pain intensity, pain interference, anxiety, and depression), we performed four linear regression analyses (one for each criterion variable) with the J-PCS total scores and subscales as the predictor variables separately while controlling for demographic variables (age, gender, and pain duration). For each model, two separate steps 3 and 4 are presented, one using PCS subdomains as predictors and the other using the PCS total score as a predictor. In the regression analyses predicting pain interference, anxiety, and depression, pain intensity was entered as a control variable; in the analyses predicting pain intensity and pain interference, anxiety and depression were entered as control variables, which could influence both outcomes and catastrophizing.

Ethical Considerations

This study was approved by the Kyushu University Hospital Institutional Review Boards. All participants provided written informed consent prior to their participation.

Results

Participant Characteristics

One hundred and sixty Japanese patients presenting with chronic pain at the department of psychosomatic medicine in Kyushu University Hospital participated in this study. Age, gender, and pain-related characteristics of the sample are presented in Table 1. The average duration of pain reported by the study participants was about 4.8 years (range: 3 months to 40 years). The most common primary pain locations were the abdomen (15.0%), the lower back (14.4%), and the lower limb (12.5%). Other pain locations of the study participants are listed in Table 1. When we consider not only primary pain location

Table 1 Demographic characteristics of the study sample (N = 160)

Variable	Mean (SD) or Number (%)
Mean (SD) age, in years	51.27 (16.39)
Mean (SD) pain duration, in months	57.74 (79.78)
Gender	
Number (percent) of men	48 (30.0%)
Number (percent) of women	112 (70.0%)
Number (percent) married	79 (49.0%)
Primary pain location	
Abdominal pain, number (%)	24 (15.0%)
Low back pain, number (%)	23 (14.4%)
Leg pain, number (%)	20 (12.5%)
Head pain, number (%)	16 (10.0%)
Upper back pain, number (%)	16 (10.0%)
Neck pain, number (%)	10 (6.3%)
Shoulder pain, number (%)	10 (6.3%)
Arm and/or hand pain, number (%)	9 (5.6%)

SD = standard deviation.

Table 2 Means and standard deviations of study variables (N = 160)

Variable	Mean (SD)
Pain Catastrophizing Scale	
Total	33.85 (10.21)
Rumination	16.06 (3.86)
Helplessness	11.37 (5.09)
Magnification	6.42 (3.32)
Brief Pain Inventory	
Intensity	
Worst pain intensity	7.73 (2.17)
Least pain intensity	3.53 (2.66)
Average pain intensity	6.14 (2.05)
Current pain intensity	5.42 (2.75)
Composite intensity score	5.76 (2.03)
Interference	
Composite intensity score	5.80 (2.50)
Hospital Anxiety and Depression Scale	
Anxiety	8.07 (4.89)
Depression	10.00 (4.92)

HADS = Hospital Anxiety and Depression Scale; SD = standard deviation.

but also other pain locations, 70% of participants had pain in lower back, 63% in upper back, 57% in head, and 49% in abdomen. Almost all patients (92.5%) had multiple pain locations (average of 5.6 locations).

Means and Standard Deviations of the Study Variables

There were no missing data. The means and standard deviations of the study variables are reported in Table 2. Overall, the total score of the J-PCS appears to be somewhat higher than that found in English samples (common range of means in English-speaking samples, 23.8–28.0; our sample, 35.04) [24,42].

Confirmatory Factor Analyses

Based on the results of the preliminary modification indices [52] provided by the AMOS output, correlations between the error terms associated with items were allowed [33,53] (Figure 1). An examination of the content of these items shows that they appear to reflect and share some redundancy in content related to Helplessness. When the model was modified, the three-factor structure [34] was most consistent with the CFA findings in this study, as reflected by the IFI, RMSEA, CFI, and the AIC values (see Table 3).

Internal Consistency and Reproducibility of the J-PCS

The ICCs (Cronbach's α's) for the Helplessness, Rumination, and total J-PCS were acceptable; 0.77, 0.72, and 0.84, respectively. However, and consistent with previous findings regarding this scale, the internal consistency coefficient for the Magnification scale was marginal (Cronbach's $\alpha = 0.69$). The J-PCS scores demonstrated adequate to excellent test–retest reliability, with ICC values

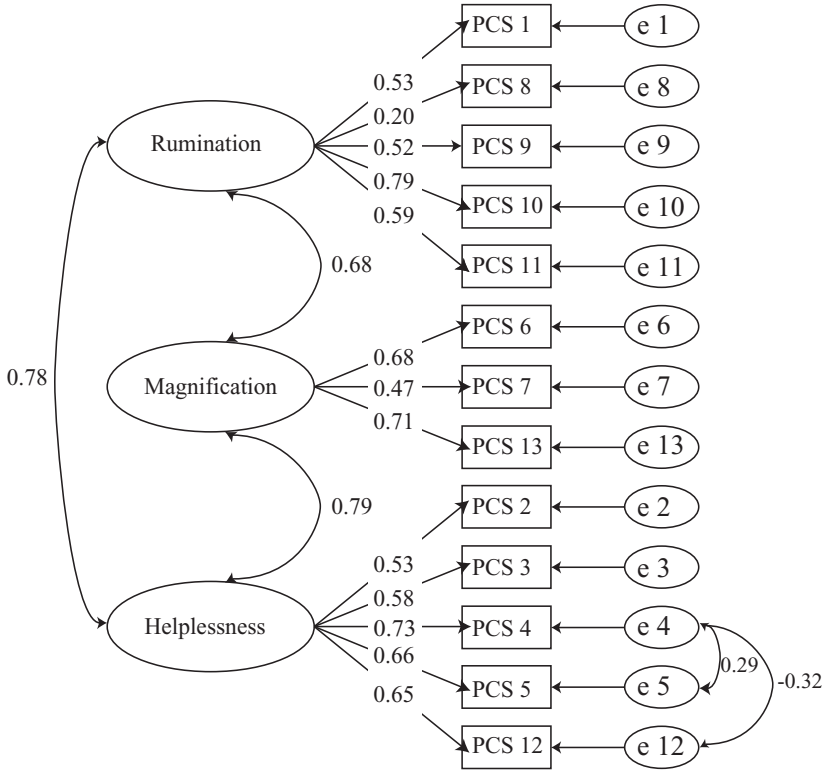

Figure 1 Three-factor model of the Japanese Pain Catastrophizing Scale (J-PCS) in patients with pain with standardized parameter estimates. The error terms allowed to covary were items 4 and 5 (e4, e5) and items 4 and 12 (e4, e12) from the Helplessness factor.

Table 3 Goodness-of-fit values for the different models tested (N = 160)

	χ^2 (df)	IFI	RMSEA	CFI	AIC
Model 1					
Two oblique factors (7 + 6 items)	228.76 (64)	0.82	0.10	0.82	308.76
Model 2					
Three oblique factors (6 + 3 + 4 items)	209.54 (62)	0.84	0.10	0.84	267.54
Model 3					
Three varimax factors (5 + 3 + 5 items)	109.30 (60)	0.91	0.07	0.91	171.31

Model 1 = two-model factor structure suggested from the findings of Osman et al. and Chibnall and Tait [34,35]; model 2 = three-factor structure suggested by the findings of Van Damme et al. and by D'Eon et al. [27,33]; model 3 = three-factor structure suggested by the findings from the current study (with correlation between the error terms associated with items 4 and 5 (e4, e5) and items 4 and 12 (e4, e12); AIC = Akaike information criterion; CFI = comparative fit index; IFI = incremental fit index; RMSEA = root mean square error of approximation.

ranging from 0.73 to 0.91. The ICC (95% confidence interval) was 0.86 (0.79, 0.94) for Helplessness, 0.91 (0.80, 0.96) for Magnification, 0.73 (0.40, 0.88) for Rumination, and 0.90 (0.79, 0.95) for the total J-PCS score. The average test–retest interval for the reliability sample of 30 participants was 12.1 days (range: 7–28 days).

Associations Between the J-PCS Scores and Criterion Variables

Univariate Analyses

All four of the J-PCS scales showed significant univariate associations with the four criterion variables assessing pain intensity, pain interference, anxiety, and depression (see Table 4). The univariate associations were strongest for the PCS Helplessness scale predicting three of the criterion variables (pain intensity, pain interference, and depression), although the PCS Magnification score evidenced the strongest association with anxiety.

Regression Analyses

The results of the regression analyses predicting the criterion variables from the J-PCS total scores and subdomain scores (controlling for age, gender, and pain duration in every analyses; controlling for pain intensity in analyses predicting pain interference, anxiety, and depression; and controlling for anxiety and depression in analyses predicting pain intensity and pain interference) are presented in Table 5. As can be seen, and consistent with the univariate analyses, the J-PCS scales made a significant contribution to the prediction of pain intensity, pain interference, anxiety, and depression. The significant effects for the J-PCS predicting pain intensity and pain interference remained, even when controlling for the demographic variables (age, gender and pain duration), pain intensity, anxiety, and depression (additional variance accounted for by the J-PCS ranged from 3% for predicting pain interference and 8% for predicting pain intensity). Similarly, the significant effects for the J-PCS scales predicting psychological functioning remained, even when controlling for the demographic variables (age, gender and pain duration) and pain intensity (additional variance accounted for by the J-PCS scales ranged from 11% for predicting depression to 25% for predicting anxiety). The J-PCS Helplessness scale made a significant independent contribution to the prediction of three of the criterion variables (pain intensity, pain interference, and depression). Especially, for pain interference, only the Helplessness scale made a significant independent contribution, whereas total PCS score did not. The J-PCS Magnification scale made a significant and unique contribution to the prediction of anxiety. In every case, consistent with the univariate analyses, the direction of the

Table 4 Correlation coefficients between the Japanese Pain Catastrophizing Scale scores and pain severity, pain interference, anxiety, and depression (N = 160)

	Japanese Pain Catastrophizing Scale			
	Rumination	Helplessness	Magnification	Total
BPI pain intensity composite score	0.20**	0.35***	0.27***	0.35***
BPI pain interference composite score	0.19**	0.47***	0.31***	0.41***
HADS anxiety	0.30***	0.42***	0.52***	0.50***
HADS depression	0.20**	0.39***	0.24**	0.36***

** $P < 0.01$; *** $P < 0.001$.
BPI = Brief Pain Inventory; HADS = Hospital Anxiety and Depression Scale.

Table 5 Hierarchical regression results predicting pain intensity, pain interference, depression, and anxiety from catastrophizing (N = 160)

Step and Variables	Total R^2	ΔR^2	*F*-change	Beta to Enter	*t*
A. Criterion: Pain intensity (BPI intensity score)					
Step 1: Demographic and pain history variables	0.02	0.02	1.10		
Age				0.13	1.64
Gender				0.03	0.36
Pain duration				–0.10	–1.35
Step 2: Depression and anxiety	0.08	0.06	5.15**		
Depression				0.08	0.80
Anxiety				0.02	0.20
Step 3: PCS subdomains scores	0.17	0.08	4.91**		
J-PCS Rumination				–0.05	–0.55
J-PCS Helplessness				0.29	2.90**
J-PCS Magnification				0.10	1.02
Step 3′: PCS total scores	0.15	0.06	11.01**	0.29	3.32**
B. Criterion: Pain interference (BPI interference score)					
Step 1: Demographic and pain history variables	0.02	0.02	1.24		
Age				0.17	2.05**
Gender				–0.01	–0.21
Pain duration				–0.03	–0.52
Step 2: Pain intensity	0.34	0.31	72.70***		
BPI intensity score				0.42	6.93***
Step 3: Depression and anxiety	0.53	0.19	30.82***		
Depression				0.32	4.71***
Anxiety				0.12	1.58
Step 4: PCS subdomains scores	0.55	0.03	2.89***		
J-PCS Rumination				–0.12	–1.80
J-PCS Helplessness				0.21	2.81**
J-PCS Magnification				–0.02	–0.23
Step 4′: PCS total scores	0.53	0.00	1.11	0.07	1.05
C. Criterion: Anxiety (HADS anxiety score)					
Step 1: Demographic and pain history variables	0.01	0.01	0.27		
Age				–0.03	–0.49
Gender				0.05	0.69
Pain duration				0.06	0.82
Step 2: Pain intensity	0.06	0.05	8.28**		
BPI intensity score				0.05	0.68
Step 3: PCS subdomains scores	0.31	0.25	18.50***		
J-PCS Rumination				0.03	0.35
J-PCS Helplessness				0.17	1.87
J-PCS Magnification				0.41	4.92***
Step 3′: PCS total scores	0.26	0.21	43.31***	0.49	6.58***
D. Criterion: Depression (HADS depression score)					
Step 1: Demographic and pain history variables	0.00	0.00	0.17		
Age				0.01	0.06
Gender				0.02	0.32
Pain duration				0.04	0.50
Step 2: Pain intensity	0.50	0.05	7.62**		
BPI intensity score				0.08	1.03
Step 3: PCS subdomains scores	0.16	0.11	6.82***		
J-PCS Rumination				–0.01	–0.16
J-PCS Helplessness				0.35	3.48***
J-PCS Magnification				0.04	0.44
Step 3′: PCS total scores	0.14	0.09	16.01***	0.32	4.00***

** $P < 0.01$; *** $P < 0.001$.

BPI = Brief Pain Inventory; J-PCS = Japanese Pain Catastrophizing Scale; HADS = Hospital Anxiety and Depression Scale.

Note: Each criterion variable was predicted with the PCS subscales and the PCS total score entered into the final step (steps 3 or 3′, or steps 4 or 4′, respectively). The beta weights listed are from the final equation after all other variables have been entered.

significant associations were in the hypothesized direction (i.e., greater catastrophizing associated with greater pain intensity, pain interference, anxiety, and depression).

Discussion

This investigation is the first to examine the factor structure of the J-PCS in a clinical sample of Japanese patients with chronic pain. It is also one of the few studies to examine the associations between the subdomains of catastrophizing assessed by the PCS and measures of pain and functioning, and the first study that we are aware of to examine the associations between the PCS subdomains and anxiety. The findings have important implications for studying the importance of catastrophizing, especially for studying the individual catastrophizing domains vs global catastrophizing as a psychological variables contributing to dysfunction in patients with chronic pain across cultures.

The results of CFA indicated that the best solution for sample of patients with chronic pain is the three-factor structure, which is the most common structure reported in the literature [30,40,41,53]. This supports a conclusion that catastrophizing—at least as measured by the PCS—is made up of three subdomains. Moreover, this solution appears to generalize across cultures, supporting its generalizability. We found a better fit for the factor structure with item 1 in the Rumination scale (as opposed to in the Helplessness scale, as suggested by the original PCS model). A closer examination of item 1 ("I worry all the time about whether the pain will end") suggests that it may reflect Rumination more than Helplessness, consistent with our findings. One study with a German translation of the PCS also indicated differences in which an item (item 12 of the PCS) loaded on factor inconsistent with the original PCS scoring. The difference in loadings found in different studies could reflect either (or both) 1) random variation between samples, regardless of culture or language, or 2) cultural differences in how the PCS items are interpreted. Further studies should examine the reliability of this finding in other samples of Japanese-speaking patients, as well as, perhaps, in samples of individuals that speak other languages for which a PCS translation is available.

The results from the regression analyses indicated that it might be more useful to examine and understand the associations between catastrophizing subdomains and measures of patient functioning, then to understand the associations between global catastrophizing and patient functioning. Specifically, like some previous studies (e.g., [11–15]), we found that the Helplessness catastrophizing domain was most closely associated with most pain-related criterion variables, independent of anxiety and depression, although the magnification subdomain was most strongly associated with anxiety in our sample. Although each subscale was correlated significantly with the indices of emotional distress, helplessness catastrophizing appears to contribute unique variance to the prediction of most pain-related criterion variables, even when controlling for emotional distress. The extent to which our findings regarding magnification catastrophizing and anxiety would replicate in sample of patients from other cultures or who speak other languages is not clear, as no prior study has examined the individual PCS's associations with measure of anxiety.

As a group, the findings regarding the individual scales' associations and the criterion variables suggest that helplessness catastrophizing (e.g., "I feel I can't go on") may be the most important catastrophizing domain that predicts patient functioning across different languages and cultures, and that clinicians should perhaps pay closest attention to reducing this type of catastrophizing cognition, relative to other catastrophizing cognitions. The findings also raise the intriguing possibility that magnification cognitions (e.g., "I become afraid that the pain may get worse") may be particularly important to anxiety, at least in Japanese-speaking patients. Although it is not possible to draw causal conclusions from correlational data such as those collected in this study, our findings raise the intriguing possibility that when patients have a tendency to think magnifying catastrophic thoughts, treatment focused on decreasing this magnification could act to decrease their anxiety. Experimental research testing this hypothesis is warranted.

The association between catastrophic helplessness and anxiety might be weak because of the high arousal nature of anxiety symptoms. Catastrophic helplessness may elicit feelings of "hopelessness" and "giving up" rather than feelings of "helplessness" or "threat," which might explain why this type of catastrophizing is more closely related to depression than anxiety [54]. On the other hand, catastrophic magnification has been hypothesized to be most closely related to primary appraisal processes, where individuals may focus on and exaggerate the threat value of painful stimuli [1]. By focusing the patient's attention on pain sensations and exaggerating the threat value of pain symptoms, magnification cognitions may also increase anxiety-related emotional distress (e.g., feelings of "fear," "worry," "dread," and "uneasiness") associated with the pain experience.

The study has a number of limitations that should be considered when interpreting the results. This study represents the first validation of the J-PCS in a clinical mixed chronic pain sample, and the sample was selected from a specific clinic (a university-based psychosomatic medicine clinic) whose patients may differ in important ways from other clinics in Japan that serve patients with chronic pain. Patients referred to the Department of Psychosomatic Medicine in Kyushu University Hospital tend to be seen after a great deal of "doctor shopping" and to be more complex and distressed, relative to those referred to general hospital clinics. This could be one reason why the mean catastrophizing score for participants in this study (35.04) was higher than the mean PCS score (27.96) reported by Sullivan et al. [24] by patients in a multidisciplinary

treatment center specializing in the management of persistent pain disorders. It is possible, therefore, that the current findings may not generalize to all individuals with chronic pain in different pain locations and diseases who speak Japanese or who live in Japan. In addition, there were more women (70%) than men (30%) in our sample. Further study is therefore needed in other patient populations to help determine the reliability of the current findings in these other populations. Furthermore, the analyses testing the validity of the J-PCS were based on cross-sectional data, which means that causal conclusions cannot be drawn from the analyses. Thus, it cannot be determined from this study if the significant associations found were because: 1) catastrophizing influences pain interference, anxiety, and depression; 2) mood and pain interference influence catastrophizing; 3) there are ongoing bidirectional causal influences among these variables; 4) these variables are all associated with some other factor that influences them all at the same time; or 5) some combination of the above. However, the findings do support associations between catastrophizing and measured by the J-PCS and other important pain-related variables in a Japanese sample of patients with chronic pain, supporting the need for future research to examine the potential causal associations among these variables. In addition, we used only one measure of each psychological variable studied. Although these were adequate measures with proven reliability and validity, the use of additional criterion measures would have provided additional support for the study findings. Finally, the internal consistency for the PCS Magnification subscale ($\alpha = 0.69$) was marginal. Although this level of reliability is consistent with the reliability of the Magnification scale reported by Sullivan et al. [1] in their original work and by other researchers [13,29–32,40–42,53], different findings might occur when and if this catastrophizing domain is assessed more reliably. Moreover, the internal consistency for the PCS Rumination subscale ($\alpha = 0.72$) was relatively low. Although the α for the Rumination was acceptable, further work to improve the reliability of both the Magnification and Rumination subscales may also improve their predictive validity. Finally, the first and second administration of the PCS in the test–retest assessment occurred in different settings (in the clinic and at home, respectively). This difference could potentially lead to an underestimation of the stability coefficients. However, despite the difference in settings, the J-PCS scores still demonstrated adequate to excellent test–retest reliability in our sample.

Despite the study's limitations, the findings provide evidence for the greater explanatory power of the PCS subdomains, relative to the PCS total score, to predict to pain-related functioning. The results also provide additional support for the three-factor structure, reliability, and validity of the J-PCS. Because almost all of the research studying pain-related catastrophizing to date has been conducted in Western culture countries, the findings are also important because they support the psychometric properties of a measure of catastrophizing that can be used to determine the generalizability of findings from individuals from Western cultures to individuals from Japan. At this point, very little is known about the structure and correlates of the PCS items as a function of race or culture; yet, such knowledge is increasingly recognized as important [55]. Our results support the use of the J-PCS for studying catastrophizing subdomains and their correlates among individuals with chronic pain who live in Japan, an East Asian country whose ethnic group, mentality, and social circumstance differ in many ways from Western countries.

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References

1 Sullivan MJ, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and validation. Psychol Assess 1995;7:524–32.

2 Jensen MP, Turner JA, Romano JM. Correlates of improvement in multidisciplinary treatment of chronic pain. J Consult Clin Psychol 1994;62:172–9.

3 Jensen MP, Turner JA, Romano JM. Changes in beliefs, catastrophizing, and coping are associated with improvement in multidisciplinary pain treatment. J Consult Clin Psychol 2001;69:655–62.

4 Burns JW, Glenn B, Bruehl S, Harden RN, Lofland K. Cognitive factors influence outcome following multidisciplinary chronic pain treatment: A replication and extension of a cross-lagged panel analysis. Behav Res Ther 2003;41:1163–82.

5 Burns JW, Kubilus A, Bruehl S, Harden RN, Lofland K. Do changes in cognitive factors influence outcome following multidisciplinary treatment for chronic pain? A cross-lagged panel analysis. J Consult Clin Psychol 2003;71:81–91.

6 Goodin BR, McGuire LM, Stapleton LM, et al. Pain catastrophizing mediates the relationship between self-reported strenuous exercise involvement and pain ratings: Moderating role of anxiety sensitivity. Psychosom Med 2009;71:1018–25.

7 Jamison RN, Link CL, Marceau LD. Do pain patients at high risk for substance misuse experience more pain? A longitudinal outcomes study. Pain Med 2009;10:1084–94.

8 Papaioannou M, Skapinakis P, Damigos D, et al. The role of catastrophizing in the prediction of postoperative pain. Pain Med 2009;10:1452–9.

9 Richardson EJ, Ness TJ, Doleys DM, et al. Depressive symptoms and pain evaluations among persons with

chronic pain: Catastrophizing, but not pain acceptance, shows significant effects. Pain 2009;147: 147–52.

10 Shelby RA, Somers TJ, Keefe FJ, et al. Pain catastrophizing in patients with noncardiac chest pain: Relationships with pain, anxiety, and disability. Psychosom Med 2009;71:861–8.

11 Sullivan MJ, Thibault P, Simmonds MJ, et al. Pain, perceived injustice and the persistence of posttraumatic stress symptoms during the course of rehabilitation for whiplash injuries. Pain 2009;145:325–31.

12 Cusens B, Duggan GB, Thorne K, Burch V. Evaluation of the breathworks mindfulness-based pain management programme: Effects on well-being and multiple measures of mindfulness. Clin Psychol Psychother 2010;17:63–78.

13 Gilliam W, Burns JW, Quartana P, et al. Interactive effects of catastrophizing and suppression on responses to acute pain: A test of an appraisal x emotion regulation model. J Behav Med 2010;33: 191–9.

14 Mounce C, Keogh E, Eccleston C. A principal components analysis of negative affect-related constructs relevant to pain: Evidence for a three component structure. J Pain 2010;11:710–7.

15 van Ittersum MW, van Wilgen CP, Groothoff JW, van der Schans CP. Is appreciation of written education about pain neurophysiology related to changes in illness perceptions and health status in patients with fibromyalgia? Patient Educ Couns 2011;85:269–74.

16 Lautenbacher S, Huber C, Baum C, et al. Attentional avoidance of negative experiences as predictor of postoperative pain ratings and consumption of analgesics: Comparison with other psychological predictors. Pain Med 2011;12:645–53.

17 Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: Relationship to patient characteristics and current adjustment. Pain 1983;17:33–44.

18 Boothby JL, Thorn BE, Stroud MW, Jensen MP. Psychosocial Factors in Pain. New York: Guilford Press; 1999.

19 Tripp DA, Nickel JC, Fitzgerald MP, et al. Sexual functioning, catastrophizing, depression, and pain, as predictors of quality of life in women with interstitial cystitis/painful bladder syndrome. Urology 2009;73: 987–92.

20 Sullivan MJ, Lynch ME, Clark AJ. Dimensions of catastrophic thinking associated with pain experience and disability in patients with neuropathic pain conditions. Pain 2005;113:310–5.

21 Tripp DA, Nickel JC, Wang Y, et al. Catastrophizing and pain-contingent rest predict patient adjustment in men with chronic prostatitis/chronic pelvic pain syndrome. J Pain 2006;7:697–708.

22 Nijs J, Van de Putte K, Louckx F, Truijen S, De Meirleir K. Exercise performance and chronic pain in chronic fatigue syndrome: The role of pain catastrophizing. Pain Med 2008;9:1164–72.

23 Vienneau TL, Clark AJ, Lynch ME, Sullivan MJ. Catastrophizing, functional disability and pain reports in adults with chronic low back pain. Pain Res Manag 1999;4:93–6.

24 Sullivan MJ, Stanish W, Waite H, Sullivan M, Tripp DA. Catastrophizing, pain, and disability in patients with soft-tissue injuries. Pain 1998;77:253–60.

25 Sullivan MJ, Neish NR. Catastrophizing, anxiety and pain during dental hygiene treatment. Community Dent Oral Epidemiol 1998;26:344–9.

26 Devoulyte K, Sullivan MJ. Pain catastrophizing and symptom severity during upper respiratory tract illness. Clin J Pain 2003;19:125–33.

27 Sullivan MJ, Stanish W, Sullivan ME, Tripp D. Differential predictors of pain and disability in patients with whiplash injuries. Pain Res Manag 2002;7:68–74.

28 Desrochers G, Bergeron S, Khalife S, Dupuis MJ, Jodoin M. Provoked vestibulodynia: Psychological predictors of topical and cognitive-behavioral treatment outcome. Behav Res Ther 2009;48:106–15.

29 Tremblay I, Beaulieu Y, Bernier A, et al. Pain Catastrophizing Scale for Francophone adolescents: A preliminary validation. Pain Res Manag 2008;13:19–24.

30 Van Damme S, Crombez G, Bijttebier P, Goubert L, Van Houdenhove B. A confirmatory factor analysis of the Pain Catastrophizing Scale: Invariant factor structure across clinical and non-clinical populations. Pain 2002;96:319–24.

31 Meyer K, Sprott H, Mannion AF. Cross-cultural adaptation, reliability, and validity of the German version of the Pain Catastrophizing Scale. J Psychosom Res 2008;64:469–78.

32 Miro J, Nieto R, Huguet A. The Catalan version of the Pain Catastrophizing Scale: A useful instrument to assess catastrophic thinking in whiplash patients. J Pain 2008;9:397–406.

33 Yap JC, Lau J, Chen PP, et al. Validation of the Chinese Pain Catastrophizing Scale (HK-PCS) in patients with chronic pain. Pain Med 2008;9:186–95.

34 Matsuoka H, Sakano Y. Assessment of cognitive aspect of pain: Development, reliability, and validation of Japanese version of Pain Catastrophizing Scale. (Japanese). Jpn J Psychosom Med 2007;47:95–102.

35 Matsuoka H, Himachi M, Furukawa H, et al. Cognitive profile of patients with burning mouth syndrome in the Japanese population. Odontology 2010;98:160–4.

36 Edwards RR, Moric M, Husfeldt B, Buvanendran A, Ivankovich O. Ethnic similarities and differences in the chronic pain experience: A comparison of African American, Hispanic, and white patients. Pain Med 2005;6:88–98.

37 Forsythe LP, Thorn B, Day M, Shelby G. Race and sex differences in primary appraisals, catastrophizing, and experimental pain outcomes. J Pain 2011;12:563–72.

38 Fabian LA, McGuire L, Goodin BR, Edwards RR. Ethnicity, catastrophizing, and qualities of the pain experience. Pain Med 2011;12:314–21.

39 Hsieh AY, Tripp DA, Ji LJ, Sullivan MJ. Comparisons of catastrophizing, pain attitudes, and cold-pressor pain experience between Chinese and European Canadian young adults. J Pain 2010;11:1187–94.

40 D'Eon JL, Harris CA, Ellis JA. Testing factorial validity and gender invariance of the Pain Catastrophizing Scale. J Behav Med 2004;27:361–72.

41 Osman A, Barrios FX, Kopper BA, et al. Factor structure, reliability, and validity of the Pain Catastrophizing Scale. J Behav Med 1997;20:589–605.

42 Chibnall JT, Tait RC. Confirmatory factor analysis of the Pain Catastrophizing Scale in African American and Caucasian Workers' Compensation claimants with low back injuries. Pain 2005;113:369–75.

43 Sullivan MJ, D'Eon JL. Relation between catastrophizing and depression in chronic pain patients. J Abnorm Psychol 1990;99:260–3.

44 Uki J, Mendoza T, Cleeland CS, Nakamura Y, Takeda F. A brief cancer pain assessment tool in Japanese: The utility of the Japanese Brief Pain Inventory—BPI-J. J Pain Symptom Manage 1998;16:364–73.

45 Tan G, Jensen MP, Thornby JI, Shanti BF. Validation of the Brief Pain Inventory for chronic nonmalignant pain. J Pain 2004;5:133–7.

46 Kalyadina SA, Ionova TI, Ivanova MO, et al. Russian Brief Pain Inventory: Validation and application in cancer pain. J Pain Symptom Manage 2008;35:95–102.

47 Radbruch L, Loick G, Kiencke P, et al. Validation of the German version of the Brief Pain Inventory. J Pain Symptom Manage 1999;18:180–7.

48 Harkapaa K. Relationships of psychological distress and health locus of control beliefs with the use of cognitive and behavioral coping strategies in low back pain patients. Clin J Pain 1991;7:275–82.

49 Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.

50 Herrmann C. International experiences with the Hospital Anxiety and Depression Scale—A review of validation data and clinical results. J Psychosom Res 1997;42:17–41.

51 Bollen KA, Curran PJ. Latent Curve Models: A Structural Equation Perspective, 1st edition. Hoboken, NJ: John Wiley & Sons; 2005.

52 Stevens JP. Applied Multivariate Statistics for the Social Sciences, 4th edition. Mahwah, NJ: Lawrence Erlbaum Associates; 2002.

53 Osman A, Barrios FX, Gutierrez PM, et al. The Pain Catastrophizing Scale: Further psychometric evaluation with adult samples. J Behav Med 2000;23:351–65.

54 Leonard MT, Cano A. Pain affects spouses too: Personal experience with pain and catastrophizing as correlates of spouse distress. Pain 2006;126:139–46.

55 Green CR, Anderson KO, Baker TA, et al. The unequal burden of pain: Confronting racial and ethnic disparities in pain. Pain Med 2003;4:277–94.